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硕 士 学 位 论 文

车载主动式红外激光夜视成像系统的研究

Research on Active Infrared Laser Night Vision Imaging System on Cars

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摘 要

汽车在夜间行驶时，由于普通汽车照明光照射距离不远，驾驶员视距较短，缩短了司机的应急反应时间，使得驾车危险性大大增加。为此，开发新型汽车红外夜视系统已成为业界人士的共识。针对目前市场上的夜视系统结构复杂，价格昂贵、抗干扰性能较差及传统主动式夜视系统的不足，本课题进行了系统分析并提出创新性的解决方案，设计了一种性能稳定、抗干扰能力强、图像信噪比高、性价比高、适用性强的主动式红外偏振激光夜视成像系统。

本文主要研究特色及创新点如下：

1. 采用激光、偏振光、光学滤波以及调制等多种技术集成，研制成功一种抗干扰能力强、图像清晰度的高性能主动式红外偏振激光夜视成像系统。
2. 基于偏振消光的原理，采用偏振光成像技术有效消除了迎面汽车同类夜视系统光源的影响，解决了会车时同波长激光干扰这一至今尚未解决的技术难题，获得了清晰图像，并申请发明专利《主动式红外偏振激光夜视成像仪》（公开号：CN1975550A）。
3. 利用普通 CCD 对红外 808nm 波长有一定的光谱响应特性，选用普通黑白 CCD 而非红外 CCD，大大降低了成本，有利于推广应用。
4. 采用 808nm 近红外激光而非用普通光源或 LED 作为光源，有效提高了夜视系统的工作距离；经过理论计算与分析，将激光功率密度控制在安全阈值内，避免了所用激光对人眼的损伤，既满足了成像激光能量要求又符合激光安全国家标准。
5. 采用经调制的脉冲激光束产生特定频率的光电流成像而非直流成像技术，进一步提高了图像信噪比，并设计了专用的调制电路。
6. 采用 808nm 窄带滤光片光学滤波技术，有效滤除了非成像波长的背景光及迎面车灯的强光干扰，进一步增强夜视系统的抗干扰能力、提高了成像质量。

本文的主要内容如下：

1. 阐述了课题的研究背景和意义，对三大类夜视系统及其国内外研究进展进行分析比较。

2. 对主动式夜视系统原理进行理论分析，并对系统的光源、迎面光照影响、震动等几个关键技术问题进行分析解决。

3. 对主动式夜视系统进行光学仿真设计，确定扩束系统的参数后进行实验分析，验证了偏振消光的可行性，成功实现了夜视系统的夜视功能。

关键词：夜视系统；安全激光；偏振消光

ABSTRACT

Because the fields of common illumination in the cars are limited, the drivers can't response in time at night, which greatly increases the driving dangers. In order to solve this problem, many researchers have developed new night vision system for cars. But commercial night vision systems in the market are complex in structure, low anti-jamming and very expensive. According to the shortcomings of traditional active night vision system, innovative solutions is brought forward and an infrared laser polarized active night vision system is designed in this thesis, which is characterized of strong stability, high anti-jamming and SNR, good price to cost and high applicability.

The characteristics and innovations of this thesis are listed as follows:

1. A kind of active infrared laser night vision imaging system, which is characterized of high anti-jamming, clear image and high performance, is designed successfully by the technical integration of laser, polarized light, optical filtering and modulation.

2. The theory of polaroid for extinction is invited in the system to eliminate the light source of congeneric night vision system from head-on cars effectively which haven't been solved as yet. A patent of invention *Active infrared polarized laser night vision imager* is applied for about this innovation, Public No: CN1975550A.

3. For its response of the spectrum is available to the wavelength 808nm, the ordinary CCD is used instead of infrared CCD to reduce the cost greatly which is propitious to application.

4. The infrared laser with the wavelength 808nm is used instead of the infrared light and LED as the light source to increase the actual work distance in this thesis. After theoretic calculation and analysis, the laser is extended and its power density is controlled to be under the safety threshold to avoid its harm to the human skin and eyes. Thus, it not only satisfies the energy request of imaging laser but also fits the

national standards.

5. Modulated pulsed laser is utilized to produce specific frequency light current imaging but not direct current imaging to enhance the SNR. The special modulation circuit is designed in this thesis.

6. To settle the jamming from the background lights and the bright lights from the head-on cars, the narrowband filter with wavelength 808nm is installed to leach light with other wavelength, so that the imaging quality and the ability of anti-jamming is farther improved.

The primary contents in this thesis are listed as follows:

1. The background and purport of this thesis are expatiated. Three kinds of night vision systems and their development are also analyzed and compared.

2. After analyzing the principle of active night vision system in theory, the technical problems of light source, disturbance from the head-on lights and vibration are analyzed and solved.

3. The active night vision system is simulated and the parameters of the concave mirror are determined. The whole system is set up and the feasibility of the method of polaroid for extinction is tested. Experiments show that the function of night vision system can be realized.

Key words: night vision system; safety infrared laser; polaroid for extinction

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